4.0 Ridership and Revenue

4.0 Ridership and Revenue

An essential input to evaluating the feasibility and advisability of high-speed rail is the ridership and revenue the system can be expected to generate. The importance of obtaining accurate ridership and revenue forecasts cannot be overstated. Ridership and revenue are key inputs to the economic impact assessment, the financing plan, and the choice of route and technology. Therefore, considerable resources were devoted to gathering new travel survey and other data and applying state-of-the-art travel demand forecasting techniques. To ensure investment grade results, the forecasts were subjected to extensive peer review.

Ridership and revenue forecasts were prepared for various configurations of the high-speed rail system, including combinations of technology, route alignment, and presence of extensions to San Diego and Sacramento. The forecasts were tested for sensitivity to assumptions about high-speed rail fare, the growth of travel demand, and the price of competing modes.

■ 4.1 Major Findings

The results presented in this chapter show that high-speed rail system ridership and passenger revenue can be expected to vary considerably depending on which technology is used, which alignment between Los Angeles and the Bay Area is selected, whether extensions to San Diego and Sacramento are built, and which fare policy chosen. In addition, while high-speed rail ridership and passenger revenue are closely related and vary in the same direction with most system changes, their relative changes can vary depending on the resulting distances traveled on high-speed rail and thus the fare yield per passenger, and how many riders represent induced trips.

Recall that the focus of the study is on *intercity* travel as opposed to *commuter* travel, such as is currently served by CalTrain or Metrolink. For the purposes of this study, intercity travel is defined as travel between metropolitan areas. Any regularly-made trip between metropolitan areas that is made three or more times per week is defined as a long-distance commute trip[1]. Most of the results presented below apply to intercity travel. Section 4.7 presents information on long-distance commute trips.

[1]This definition is consistent with the questionnaire design of the household travel survey carried out for this study.

The results presented in this chapter lead to the following conclusions:

1. The State Route 99 (SR-99) Base alignment has greater ridership and revenue potential than the Interstate 5 (I-5) alignment.

2. Higher speeds are most important for the long distance (e.g., LA-Bay Area) markets.

3. Total high-speed rail ridership is generally much more sensitive than total high-speed rail revenue to changes in high-speed rail fares.

4. High-speed rail station boardings and alightings vary greatly by station along a given alignment.

5. High-speed rail link volumes are fairly uniform along most of the length of each high-speed rail alignment between Los Angeles and the Bay Area, providing for efficient use of high-speed rail trainsets over the entire length of the Corridor.

6. High-speed rail can attract a significant volume and share of intercity travel in California, either with or without the extensions. For example:

   - A VHS system captures about 11 percent of the entire intercity travel market in the Corridor (including trips to and from the Sacramento and San Diego areas), with or without the extensions.

   - With extensions, a VHS system can capture over 20 percent of the Los Angeles-Bay Area travel market.

   - The high-speed rail market share would increase with a Maglev system.

7. The extensions to San Diego and Sacramento are very important. For example, ridership and revenue essentially double because many more city pairs are served with the extensions.

4.2 Assumptions

4.2.1 Fares and Out-of-Pocket Costs

Intercity air fares, conventional rail fares, and automobile operating costs are expected to remain constant, in real terms, between the base year (1994) and the forecast year (2015) for the baseline set of forecasts. The fares and costs for the competing modes are described in Chapter 2.0. For the baseline forecasts, high-speed rail fares are based on a linear function of distance traveled specified as a minimum $20 boarding charge plus a constant fare per mile. This specification results in a Los Angeles to Bay Area high-speed rail fare equivalent to 70 percent of the average 1995 Los Angeles to Bay Area air fare. Additional analyses tested the sensitivity of the ridership forecasts to fare and cost assumptions by varying air fares, high-speed rail fares, and automobile operating costs as described later in this chapter. High-speed rail fares and revenues in this chapter are presented in 1995 dollars.

4.2.2 Alignment and Technology

The choice of alignment and technology affects system accessibility and travel times, and thus the competitiveness of the high-speed rail system. The route alignments and technology assumed for the ridership and revenue forecasts correspond to the alternatives developed during Phase 2 of the Corridor Evaluation Study (see Chapter 3.0). Preliminary and refined ridership and revenue forecasts were prepared for the three technology categories (HS, VHS, and Maglev) and five basic alignment options (State Route 99 (SR-99) Base, SR-99 Short, SR-99 Long, I-5 Short, and I-5 Long). At the Commission's direction, subsequent ridership and revenue analysis focused solely on variations of the SR-99 Corridor with VHS or Maglev technology. Refined ridership forecasts for the three technology options and the two major corridors are presented in Table 4.1.[2]

The following sections discuss ridership and revenue forecasts for the SR-99 Corridor with VHS or Maglev technology in more detail. For easy reference, Figures 4.1, 4.2, and 4.3 illustrate the SR-99 Corridor alignment options, including options for both the basic system connecting Los Angeles and the Bay Area and potential extensions to San Diego and Sacramento. For each alignment (SR-99 Base, Short, and Long), ridership and revenue forecasts were prepared for both the basic system (from San Francisco to Los Angeles only) and the Extended System (including extensions to San Diego and Sacramento). If not otherwise specified, forecasts presented in this chapter are for the basic system with the SR-99 Base alignment and VHS technology.

4.3 Baseline Forecasts

Year 2015 ridership for the basic system ranges from 10.7 million (VHS technology operating on the SR-99 Short alignment) to 14.9 million (Maglev technology operating on the SR-99 Base alignment) annual one-way passenger trips. Year 2015 ridership for the Extended System ranges from 19.7 million (VHS technology, SR-99 Short alignment) to 27.1 million (Maglev technology, SR-99 Base alignment). Basic system annual passenger revenue ranges from $364 million (VHS, SR-99 Short alignment) to $513 million for a (Maglev, SR-99 Base alignment). The Extended System would generate between $647 million (VHS technology, SR-99 Short alignment) and $920 million (Maglev technology, SR-99 Base alignment) in revenue.

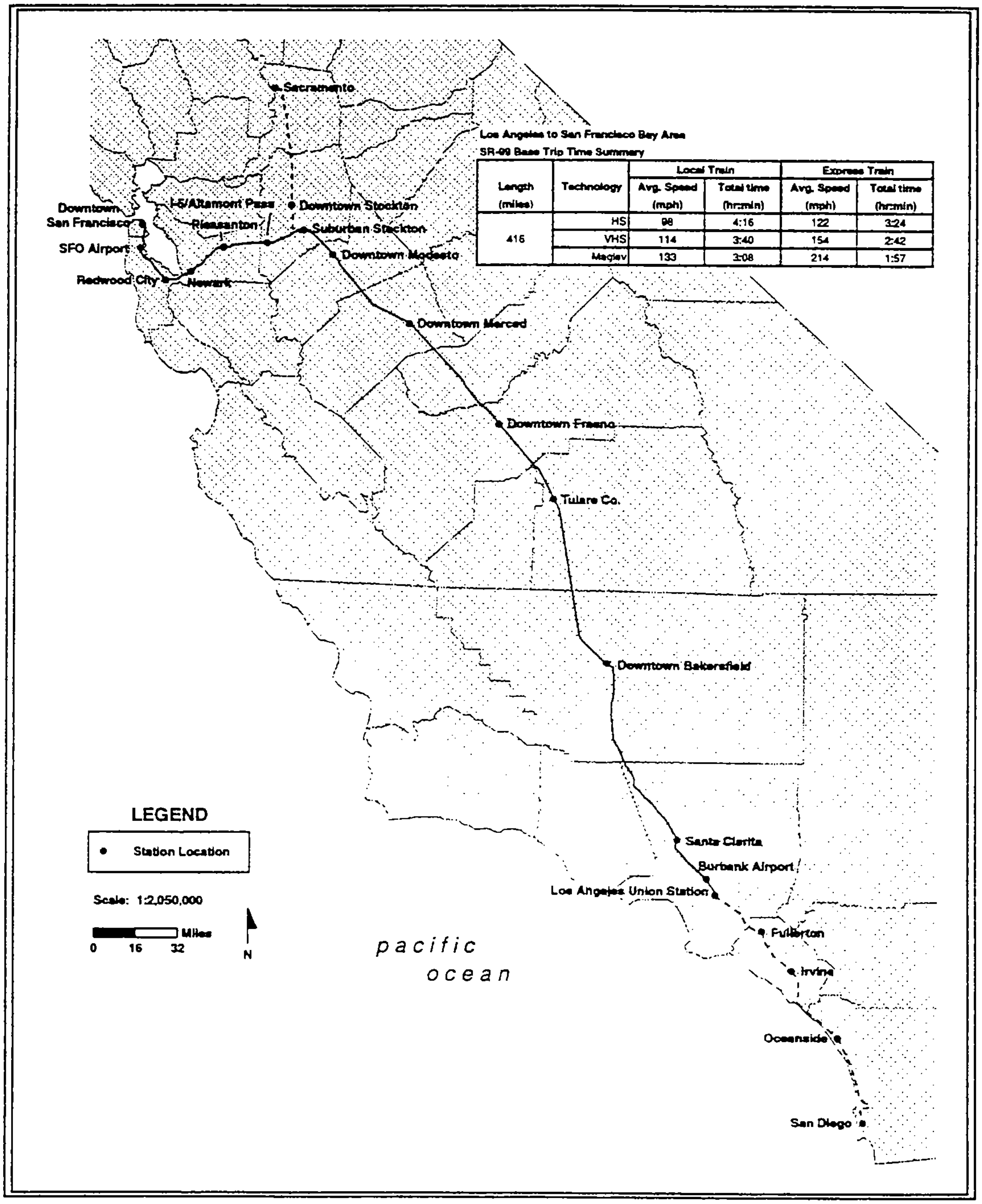
[2]The refined forecasts did not differ materially from the preliminary forecasts.

Table 4.1 Year 2015 Baseline Forecast Summary – Ridership and Revenue by Alignment and Technology

	HS		VHS		Maglev	
Alignment	Ridership (000s)	Revenue (1995 $ million)	Ridership (000s)	Revenue (1995 $ million)	Ridership (000s)	Revenue (1995 $ million)
Without extensions						
I-5 Short	6,991	$237	10,448	$369	13,515	$487
I-5 Long	6,449	$214	9,709	$339	13,154	$472
SR-99 Short	7,081	$227	10,724	$364	14,235	$498
SR-99 Long	6,923	$208	10,251	$333	14,117	$481
SR-99 Base	7,816	$242	11,214	$370	14,952	$513
With extensions to San Diego and Sacramento						
I-5 Short	14,748	$469	20,054	$678	26,047	$915
I-5 Long	14,940	$475	19,678	$663	25,509	$892
SR-99 Short	14,333	$436	19,757	$647	26,285	$903
SR-99 Long	14,965	$445	19,701	$630	25,782	$868
SR-99 Base	17,492	$539	21,206	$690	27,106	$920

Source: Charles River Associates, 1996.

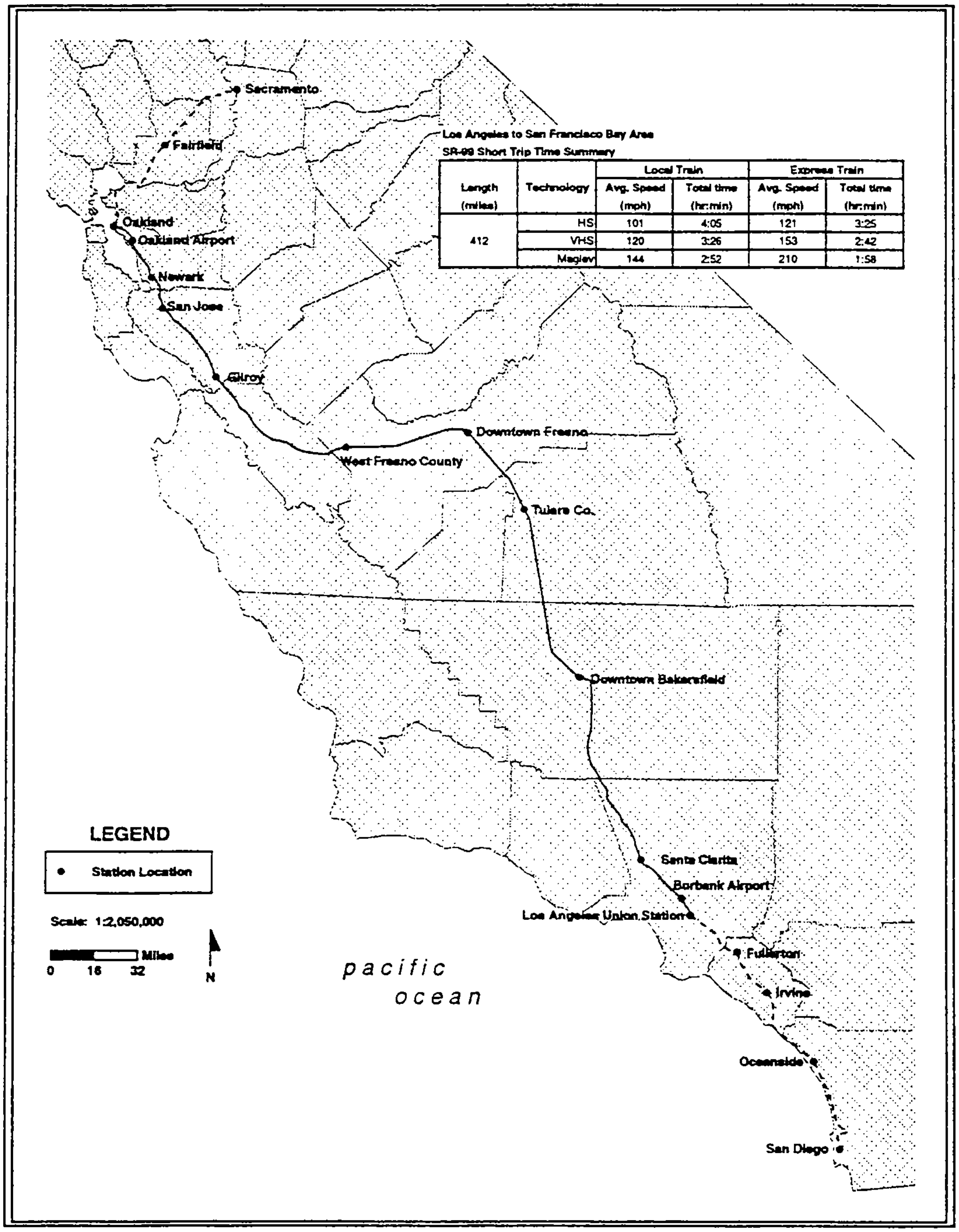
Figure 4.1 SR-99 Base Alignment (with extensions shown)



Length (miles)	Technology	Local Train Avg. Speed (mph)	Local Train Total time (hr:min)	Express Train Avg. Speed (mph)	Express Train Total time (hr:min)
416	HS	98	4:16	122	3:24
	VHS	114	3:40	154	2:42
	Maglev	133	3:08	214	1:57

Source: Parsons Brinckerhoff.

Figure 4.2 SR-99 Short Alignment (with extensions shown)

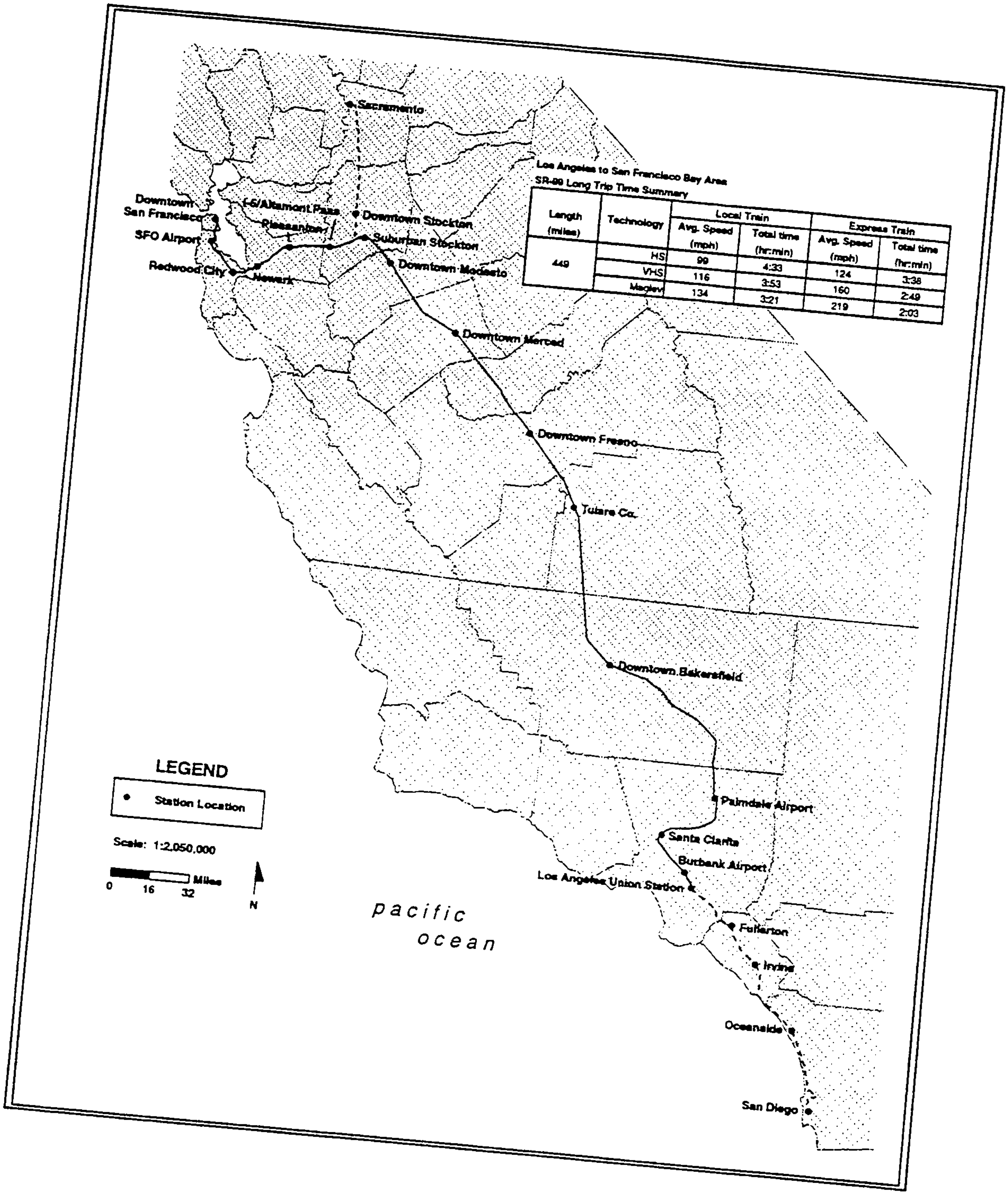


Length (miles)	Technology	Local Train Avg. Speed (mph)	Local Train Total time (hr:min)	Express Train Avg. Speed (mph)	Express Train Total time (hr:min)
412	HS	101	4:05	121	3:25
	VHS	120	3:26	153	2:42
	Maglev	144	2:52	210	1:58

Note: San Francisco is the northern terminal station for the system without extensions and Oakland is the northern terminal for the system with the extensions.

Source: Parsons Brinckerhoff.

Figure 4.3 SR-99 Long Alignment (with extensions shown)



Los Angeles to San Francisco Bay Area
SR-99 Long Trip Time Summary

Length (miles)	Technology	Local Train Avg. Speed (mph)	Local Train Total time (hr:min)	Express Train Avg. Speed (mph)	Express Train Total time (hr:min)
449	HS	99	4:33	124	3:38
	VHS	116	3:53	160	2:49
	Maglev	134	3:21	219	2:03

Source: Parsons Brinckerhoff.

Some of the results that were carried forward to the Economic Impact or Financing Options studies, included:

- The basic system with VHS technology operating over the SR-99 Base alignment would attract 11.2 million annual passenger trips and generate $370 million in revenue.
- The basic system with Maglev technology operating over the SR-99 Base alignment would attract almost 15 million annual passenger trips and generate $513 million in revenue.
- With extensions to San Diego and Sacramento, the SR-99 Base alignment with VHS technology would attract 21.2 million annual passenger trips for $690 million in revenue.
- With extensions to San Diego and Sacramento, the SR-99 Base alignment with Maglev technology would attract 27.1 million annual passenger trips for $920 million in revenue.

4.3.1 Market Share

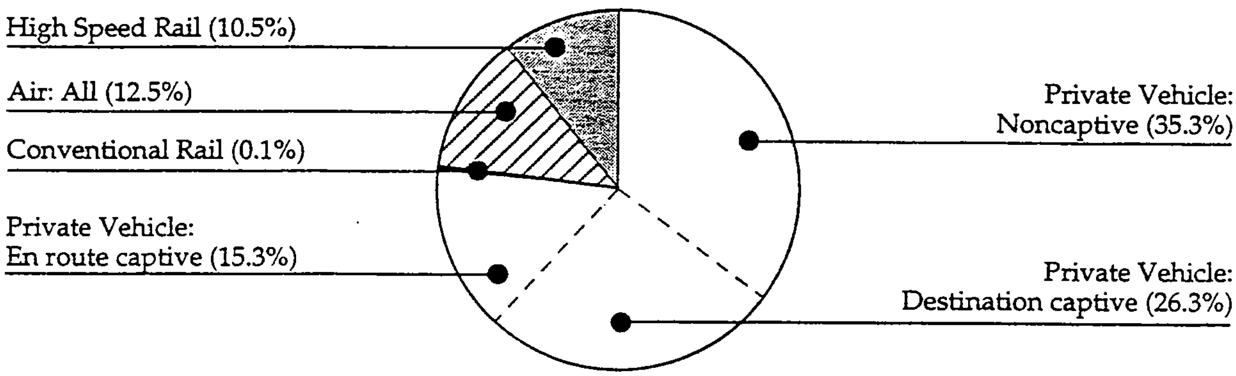
Using the SR-99 Base alignment with VHS technology as an illustration, the basic high-speed rail system would capture about 11 percent of the total intercity travel market in the Corridor. The total travel market is defined as all city pairs in the Corridor, regardless of whether the city pairs are served directly by high-speed rail (the basic system would capture some San Diego – San Francisco trips, even without direct high-speed service to San Diego, for example). The private automobile would remain the dominant mode of intercity passenger travel with a 77 percent market share. Airlines would retain 13 percent of the market and fewer than 1 percent of intercity trips would remain on conventional rail services. With the addition of the extensions, high-speed rail can serve many more trip origins and destinations directly. This advantage is more directly competitive with the air mode; thus, the airline share drops to 10 percent and the private vehicle share rises to 79 percent in the overall intercity travel market (see Figure 4.4).

High-speed rail's greatest market shares would be found in the medium to long distance markets. The basic system (SR-99 Base alignment, VHS technology) would capture over 20 percent of the Bay Area – Los Angeles market and nearly 40 percent of the Los Angeles – Sacramento markets (Figure 4.5). With Maglev technology, these percentages would rise to 39 and 51 percent, respectively.[3] While high-speed rail would serve a fair amount of intercity travel in the shorter distance markets such as Los Angeles – San Diego, most trips in these markets would still be made by automobile.

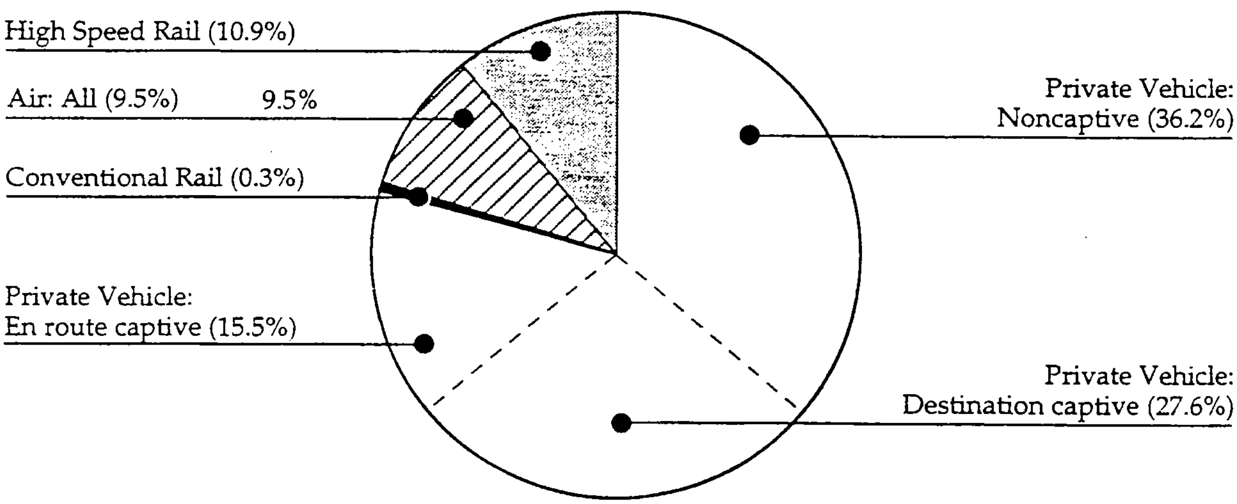
[3]Recall that the total intercity travel market is defined as all city pairs in the California Corridor, including San Diego and Sacramento, regardless of whether the extensions are assumed to be in place.

Figure 4.4 Market Shares with High-Speed Rail (SR-99 Base Alignment, VHS Technology, Year 2015)

Basic System

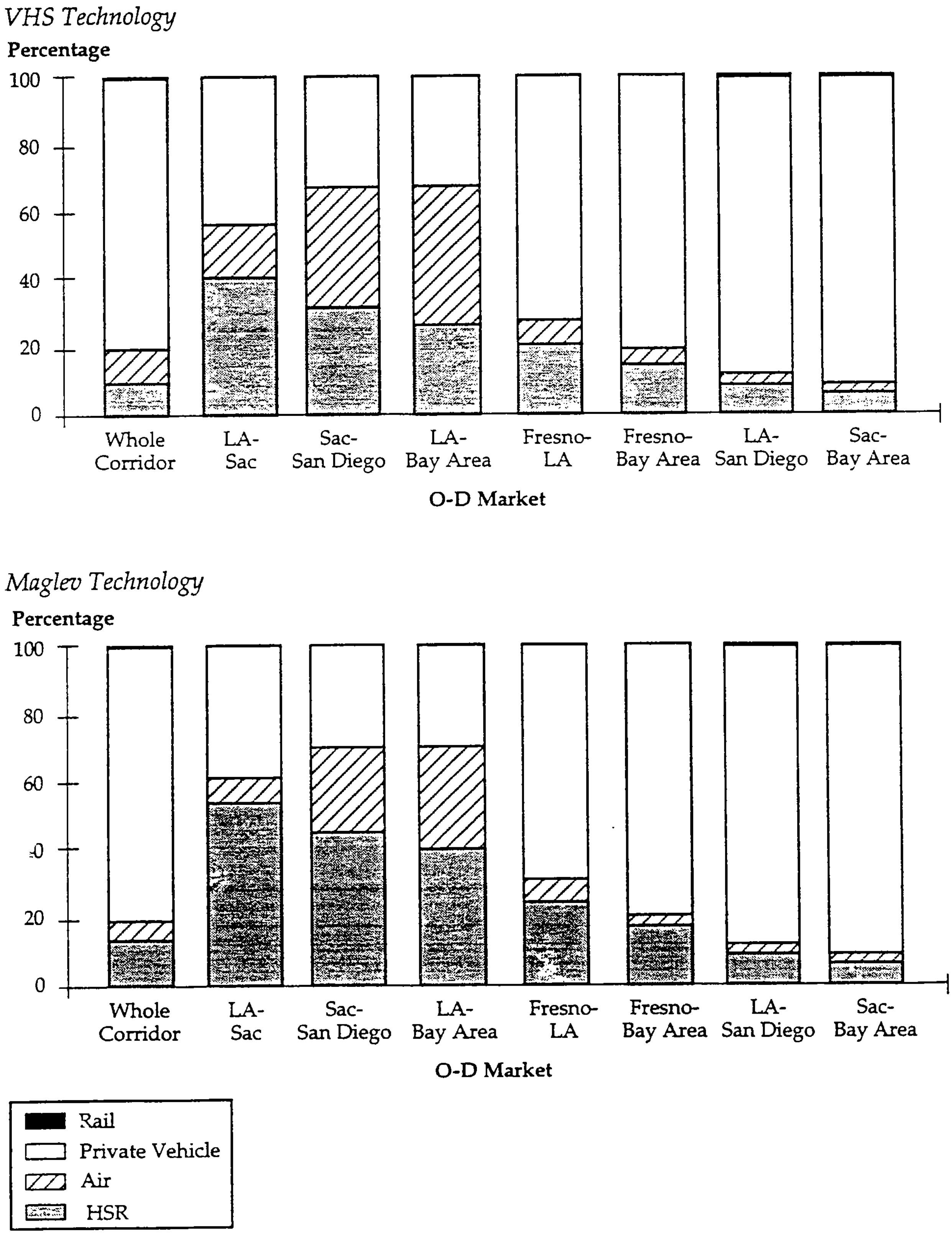


Extended System



Source: Cambridge Systematics, Inc. with data from Charles River Associates, 1996.

Figure 4.5 Modal Shares in Principal City Pairs for the Full Corridor (Extended System, SR-99 Base Alignment, Year 2015)



4.3.2 Ridership by Origin-Destination Market Segment

The bulk of the basic system's high-speed rail ridership comes from the Los Angeles-Bay Area origin-destination (OD) market. For example, 57 percent of the ridership on an SR-99 alignment with VHS technology comes from the Los Angeles-Bay Area OD market. The second most important OD market segment is between the major metropolitan areas and the Central Valley (e.g. Fresno to Los Angeles). Since faster operating speeds have the greatest impact on longer distance markets, a Maglev system would draw proportionately more of its ridership from the Los Angeles-Bay Area market. With the extensions to San Diego and Sacramento in place, trips with an origin or destination along these lines would approach the Los Angeles – Bay Area OD market in importance. For example, almost half the trips on the extended system (SR-99 Base alignment, VHS technology) would have an origin or destination at one of the extension stations (see Figure 4.6).

4.3.3 Ridership by Source

The majority of high-speed rail trips on the basic system (SR-99 alignment, VHS technology) would otherwise have been made by air. For example, 53 percent of the basic system ridership is diverted from local air (see Figure 4.7). Most of these diverted air trips will come from the local air market; relatively few connecting air trips are captured. A significant number of private vehicle trips are also diverted, due to the sheer number of private vehicle trips being made. While high-speed rail will capture about 37 percent of local air travelers within the Corridor, only about 5 percent of the private vehicle travelers would switch to the high-speed rail system.

Induced demand (trips which would not have been made if high-speed rail were not available) accounts for about 5 percent of the overall system ridership. Nevertheless, induced demand is a very important part of ridership in the shorter distance markets and between the smaller metropolitan areas. For example, 37 percent of the high-speed rail ridership between Stockton and the Bay Area consists of induced trips (see Table 4.2). Currently, air service between these smaller cities is either nonexistent or is characterized by high fares and low service frequencies.

Maglev's higher speeds would make the system more competitive with the air mode. Thus, a greater share of the Maglev system's ridership is diverted from air than for the VHS system.

4.3.4 Revenue

System revenue generally follows ridership. However, longer distance trips have higher fares per trip than shorter distance trips. Thus, the system alternatives which rely more on shorter trips generate proportionally less revenue per trip than alternatives that serve more long distance trips. For example, the basic system (SR-99 Base alignment, VHS technology) generates $370 million in revenue from 11.2 million passenger trips. With Maglev technology, the system would draw more of its ridership from longer distance trips, serving 33 percent more passengers (14.9 million) but generating 38 percent more revenue ($513 million).

Figure 4.6 Ridership by Origin-Destination Market Segment, Technology, and Alignment (Year 2015)

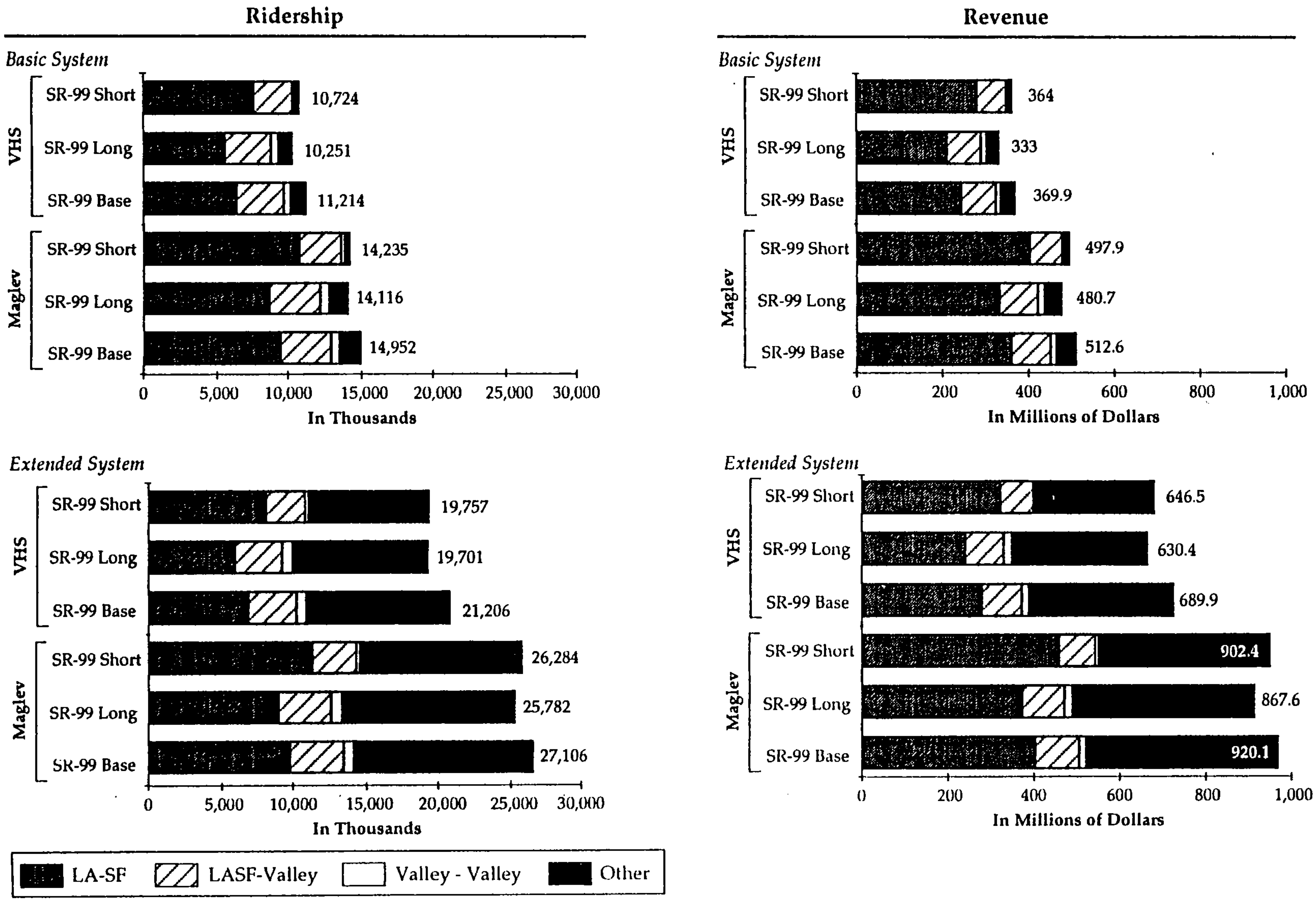


Figure 4.7 Ridership by Source, Technology, and Alignment (Year 2015)

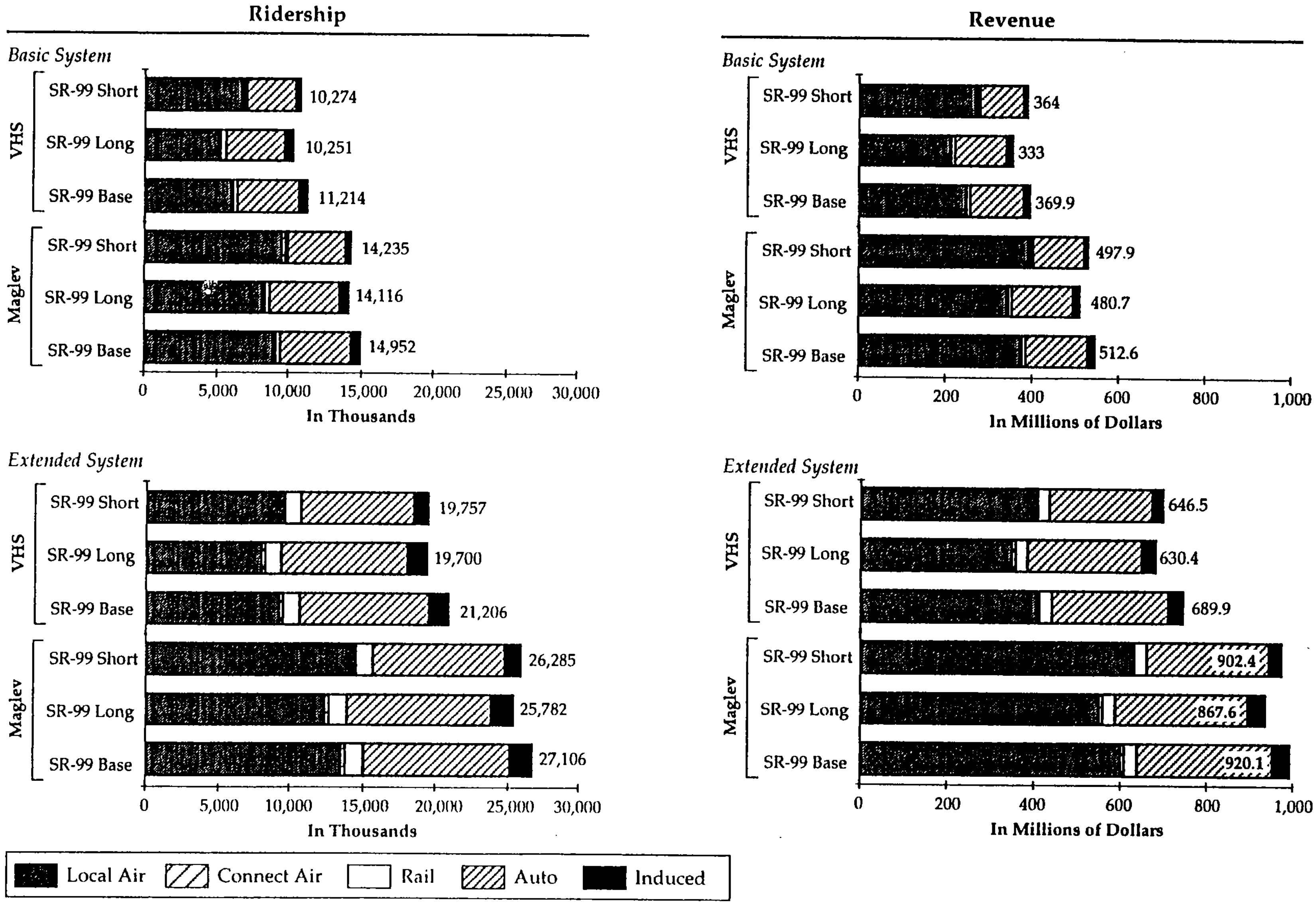


Table 4.2 Induced Demand by Origin-Destination Pair

Origin/Destination Pair	Induced Demand Percentage
Bakersfield-Fresno	23%
Bakersfield-LA	21%
Fresno-Merced	40%
Fresno-Modesto	26%
Fresno-Bay Area	14%
Merced-Modesto	76%
Merced-Bay Area	20%
Merced-Stockton	41%
Modesto-Bay Area	28%
Modesto-Stockton	80%
Stockton-Bay Area	37%

Source: Charles River Associates, 1996.

4.3.5 Trip Purpose (Business vs. Nonbusiness)

About 40 percent of the high-speed rail system's ridership will be for business travel, with the remaining 60 percent of trips for non-business purposes. A Maglev system will attract a slightly higher percentage of business travel than would a VHS system. Ridership on the SR-99 Base alignment without the extensions would be 37/63 percent business/non-business with VHS technology and 40/60 percent business/non-business with Maglev. With the extensions to San Diego, the business/non-business ratio would be 37/63 with VHS technology and 39/61 with Maglev.

4.3.6 Link Volumes and Station Activity

Two additional measures of high-speed rail ridership are the system link volumes and station activity. Link volumes are important because they affect the configuration of high-speed rail trainsets. If travel volumes show significant peaks over a route, trainsets will not be used efficiently (i.e., the trains may be less than fully-utilized over low volume segments). Fortunately, link volumes for the basic system (SR-99 Base alignment, VHS technology) are relatively uniform over its entire length (see Table 4.3).

In contrast, station activity varies greatly from station to station (see Table 4.4). The level of station activity has implications for the level of investment and facilities required at each location. Los Angeles Union station would serve the greatest number of average annual boardings and alightings in the system by far (6.9 million), a not surprising result given the population from which the station will draw. Next, in terms of station activity is the downtown San Francisco station (4.3 million) followed by the downtown Fresno station (1.7 million).

4.4 Alignment Effects

4.4.1 Los Angeles to Bay Area Options

The SR-99 alignment alternatives provide good service to the Central Valley cities while retaining competitive end-to-end travel times. The SR-99 Base alignment alternative generates the highest system revenue and ridership for all technology options. The SR-99 Short alignment attracts somewhat fewer passengers because the Panoche Pass route does not serve the upper Valley cities (Merced, Modesto, and Stockton). Additional ridership gained by serving Palmdale would be more than offset by the negative impact of longer travel times, resulting in lower ridership and revenue for the SR-99 Long alignment than the other two SR-99 options (9 percent lower for the basic system with VHS technology). Refer to Table 4.2 for a summary of forecasts by alignment.

Table 4.3 Average Annual and Daily Link Volumes in 2015 (SR-99 Base Alignment, VHS Technology)

Station 1		Station 2	Link	Annual Volume (000s)	Daily Volume (000s)
Los Angeles Union Station	to	Burbank Airport	1	6,904	19
Burbank Airport	to	Santa Clarita	2	7,881	22
Santa Clarita	to	Downtown Bakersfield	3	8,895	24
Downtown Bakersfield	to	Tulare/Kings County	4	8,840	24
Tulare/Kings County	to	Downtown Fresno	5	8,860	24
Downtown Fresno	to	Downtown Merced	6	8,642	24
Downtown Merced	to	Downtown Modesto	7	8,706	24
Downtown Modesto	to	Suburban Stockton	8	8,820	24
Suburban Stockton	to	I-5/Altamont Pass	9	8,246	23
I-5/Altamont Pass	to	Pleasanton	10	8,084	22
Pleasanton	to	Newark	11	7,389	20
Newark	to	Redwood City	12	6,257	17
Redwood City	to	San Francisco Airport	13	4,929	14
San Francisco Airport	to	Downtown San Francisco	14	4,315	12

Source: Charles River Associates, 1996.

Table 4.4 Average Annual Boardings and Alightings by Station in 2015 (SR-99 Base Alignment)

Station Name	Station	Boardings/Alightings (000s)
Los Angeles Union Station	3	6,904
Burbank Airport	5	977
Santa Clarita	6	1,014
Downtown Bakersfield	9	1,050
Downtown Fresno	12	1,687
Tulare/Kings County	17	78
Downtown Merced	19	262
Downtown Modesto	21	779
Suburban Stockton	24	1,211
I-5/Altamont Pass	26	383
Pleasanton	27	695
Newark	29	1,131
Redwood City	33	1,329
San Francisco Airport	34	613
Downtown San Francisco	35	4,315

Source: Charles River Associates, 1996.

4.4.2 Extensions

With extensions to San Diego and Sacramento, system ridership nearly doubles (see Table 4.2). For example, for a VHS system operating on the SR-99 Base alignment, ridership goes from 11.2 to 21.2 million and revenue increases from $370 to $690 million. This dramatic increase in revenue and ridership stems from the greater number of origins and destinations that the extended system can serve. For example, the extended system also serves city pairs such as Fresno-Sacramento, or San Diego-San Francisco.

However, building the extension segments alone would not result in ridership levels equal to the basic system ridership. The extensions alone generate ridership on the order of 3 million annual passengers for the San Diego line and 1-2 million on the Sacramento line.

With regard to choice of route for the extensions, the I-15 route to San Diego and the Stockton route to Sacramento generate higher ridership and revenue than the LOSSAN or Capitol Corridor routes.

4.4.3 San Jose Link (Basic System, SR-99 Base Alignment, VHS Technology)

The SR-99 Base alignment approaches the San Francisco Bay via the Altamont Pass. Under this scenario, the route would reach San Francisco via the Peninsula, bypassing direct service to San Jose. Adding a San Jose link to the SR-99 Base alignment would attract approximately 700,000 additional passenger trips and generate approximately $23 million more in revenue (see Table 4.5)

4.4.4 Terminal Stations (Basic System, SR-99 Base Alignment)

The choice of terminal stations has a noticeable impact on system ridership. In general, highest ridership and revenue can be expected from terminals at Los Angeles Union station and downtown San Francisco. For example, a southern terminus at Los Angeles Union Station attracts about a million more annual passengers than a terminus at LAX (for a VHS system originating in San Francisco). Similarly, a northern terminal in downtown San Francisco attracts over a million more trips than one at SFO, (for a VHS system originating at Los Angeles Union).

Assuming the route begins at Los Angeles Union Station, terminating the route at either Pleasanton or San Jose results in much lower system ridership and revenue than continuing on to San Francisco. Ridership for a Pleasanton terminus is about 25 percent lower than for a San Francisco terminus while revenue is between 27-29 percent lower. Ending the system at San Jose would result in more than a third less ridership than a San Francisco terminus and about 40 percent less revenue (see Table 4.6).

Table 4.5 Ridership and Revenue Impact of San Jose Link

Alignment and Technology Option	Basic System Without Extensions		With Extensions	
	Ridership (000s)	Revenue ($ million)	Ridership (000s)	Revenue ($ million)
VHS Technology				
SR-99 Short	10,724	$364	19,757	$647
SR-99 Base	11,214	$370	21,206	$690
SR-99 Base with San Jose Spur	11,919	$393	22,031	$715
Maglev Technology				
SR-99 Short	14,235	$498	26,285	$903
SR-99 Base	14,952	$513	27,106	$920
SR-99 Base with San Jose Spur	15,974	$545	28,317	$959

Note: Distance-based high-speed rail fares with Los Angeles – Bay Area at 70 percent of average air fare.

Source: Charles River Associates, 1996 (d).

Table 4.6 Ridership and Revenue Impact of Terminal Station Alternatives (SR-99 Base Alignment, No Extensions)

	Southern Terminal Options			
	L.A. Union Station		LAX	
Technology and Northern Terminal Options	**Ridership (millions)**	**Revenue ($ million)**	**Ridership (millions)**	**Revenue ($ million)**
VHS Technology				
Downtown San Francisco	11.2	$370	10.0	$323
Oakland	10.7	$352	9.7	$309
SFO	10.0	$326	9.0	$284
Pleasanton	8.4	$264	—	—
San Jose [1]	7.1	$221	—	—
Maglev Technology				
Downtown San Francisco	15.0	$513	13.4	$447
Oakland	14.5	$498	13.0	$437
SFO	13.4	$455	12.0	$391
Pleasanton	11.4	$373	—	—
San Jose[1]	9.4	$301	—	—

Notes: [1] San Jose figures assume the SR-99 Short alignment scenario.

[2] No forecasts were developed for a system terminating at Pleasanton and LAX or San Jose and LAX.

Source: Charles River Associates.

4.4.5 Outlying Stations in Central Valley Cities (SR-99 Base Alignment)

Central Valley cities may be served by stations located in or near their Central Business Districts or by station locations on the outskirts of urban areas. By removing some of the operating constraints inherent in urban areas, outlying station locations allow for slightly faster overall travel times at the price of slightly higher access times to the high-speed rail system. The ridership impact of outlying stations would be relatively minor, with the travel time or line-haul advantages generally outweighing the access effect. For the SR-99 Base alignment, the ridership impact of outlying stations would be less than 1 percent.

4.4.6 Pacheco Pass (SR-99 Short Alignment)

This variation on the SR-99 Short alignment provides direct service to San Jose while serving the Central Valley city of Merced. Using the Pacheco Pass option for approaching the Bay Area results in a slightly longer route, with slightly longer travel times overall. The total system ridership and revenue under this scenario falls between the baseline SR-99 Short and SR-99 Base forecasts. If the extensions are included, revenue and ridership are very similar to the original SR-99 Short forecasts with extensions (see Table 4.7).

4.4.7 Aqueduct Option (SR-99 Long Alignment)

Travel time differences resulting from selection of the Aqueduct option for crossing the Tehachapis under the SR-99 Long alternative would be negligible. With no other level of service impacts involved, there would be no change in the baseline revenue and ridership for the SR-99 Long alternative.

■ 4.5 Technology Effects

The selected high-speed rail technology will have a substantial impact on ridership and revenue since travel speeds and thus travel times vary significantly between technologies. As maximum operating speeds rise from VHS to Maglev, ridership increases by about a third, while revenue increases on the order of 40 percent. For example, ridership for the basic system with the SR-99 Base alignment increases from 11.2 for VHS to 14.9 million for Maglev, while revenue increases from $370 to $513 million.

Operating speed has the greatest effect on the longer distance markets. Over a longer distance trip, the travel time savings resulting from higher speeds are larger and constitute a greater proportion of the total travel time (including access, egress, waiting, and in-terminal times). Thus, higher operating speeds will benefit long distance markets such as Los Angeles to Sacramento, with relatively less benefit in the shorter or medium distance markets.

Table 4.7 Ridership Impact of Pacheco Pass Alignment

Estimated Results (Total 2015 Ridership in Millions)

		SR-99 Short	Pacheco Pass	SR-99 Base
Basic System	VHS	10.5	10.8	11.1
	Maglev	14.0	14.5	14.8
With Extensions	VHS	19.76	19.84	21.0
	Maglev	26.28	26.4	26.8

Note: Figures are for local travel only.

Source: Charles River Associates, 1996 (d).

4.6 Sensitivity to Fares and Growth Rates

Assumptions regarding high-speed rail fare levels, growth in intercity travel demand, and the price of competing modes were common to all the forecasts presented in the preceding sections. A series of sensitivity analyses, presented below, was prepared to examine how changes in these assumptions might impact the forecast results. The sensitivity analyses compare forecasts made for a system using the SR-99 Base alignment, with and without the extensions, and VHS or Maglev technology, changing only growth rates, competing prices, or high-speed rail fares, with all other assumptions held constant.

4.6.1 Auto and Air Travel Growth Rates

The travel demand models used for the baseline forecasts implied average annual growth rates of 1.2 and 2.4 percent for auto and local air travel, respectively.[4] This analysis tested the impact of higher growth rates for local air travel (3.5 percent) and auto travel (2.5 percent), both separately and in combination. The higher rates correspond to those used in a soon-to-be-released federal study. These assumptions resulted in ridership gains on the order of 11 to 15 percent for higher air or auto growth rates, and 26 percent for the combined higher growth rates (see Table 4.8). Revenue impacts followed similar patterns for the combined growth rates. Higher air growth rates, however, had a proportionately greater impact on revenue than did higher auto growth rates.

4.6.2 Price of Competing Modes

Higher Airfares

Baseline forecasts assumed that air fares remained constant in real terms over the period from 1994 to 2015. This sensitivity analysis tested the impact of setting forecast year airfares at 150 percent, 200 percent, and 300 percent of existing fare levels; also raising the high-speed rail fare structure based on 70 percent of the Los Angeles Bay-Area air fares. The higher air fares resulted in modest high-speed rail ridership gains for the basic system: up to 14 percent for the VHS system with a 300 percent airfare increase and an overall loss of ridership for the extended system (see Table 4.9). This occurs because high-speed rail fares also increase in this sensitivity analysis, diverting fewer private vehicle and conventional rail trips. The gain in ridership for the Los Angeles – Bay Area market is more than offset by the concurrent loss in the other market segments. Along with modest gains or losses in ridership, higher airfares result in significantly higher system revenues due to the much higher fares per high-speed rail passenger (revenue for the basic system with VHS technology increases to $1.3 billion or by 267 percent at the 300 percent air fare level).

[4] Growth rates for intercity rail were set to zero.

Table 4.8 Sensitivity Analysis – Air and Auto Growth Rates

Growth Rate Scenario (SR-99 Base Alignment)	Basic System (without extensions)		With Extensions	
	Ridership (000s)	Revenue ($ million)	Ridership (000s)	Revenue ($ million)
VHS Technology				
SR-99 Base	11,102	$367	20,960	$684
Air @ 3.5%	12,556 (13%)	$424 (16%)	23,161 (11%)	$772 (13%)
Auto @ 2.5%	12,590 (13%)	$406 (11%)	24,163 (15%)	$771 (13%)
Air @ 3.5% +Auto @ 2.5%	14,041 (27%)	$463 (26%)	26,359 (26%)	$859 (26%)
Maglev Technology				
SR-99 Base	14,797	$508	26,773	$911
Air @ 3.5%	16,988 (15%)	$595 (17%)	30,112 (13%)	$1,047 (15%)
Auto @ 2.5%	16,508 (12%)	$554 (9%)	30,425 (14%)	$1,013 (11%)
Air @ 3.5% +Auto @ 2.5%	18,696 (26%)	$640 (26%)	33,756 (26%)	$1,148 (26%)

Note: Figures are for local travel only. Percent change from baseline scenario indicated in parentheses.

Source: Charles River Associates, 1996 (c).

Table 4.9 Sensitivity Analysis – Air Fares

Air Fare Scenario (SR-99 Base Alignment)	Basic System (without extensions) Ridership (000s)	Basic System (without extensions) Revenue ($ million)	With Extensions Ridership (000s)	With Extensions Revenue ($ million)
VHS Technology				
Base Air Fare	11,102	$367	20,960	$684
150% Base	11,204 (2%)	$560 (53%)	19,655 (-6%)	$951 (39%)
200% Base	11,674 (5%)	$791 (116%)	18,740 (-11%)	$1,26 (79%)
300% Base	12,681 (14%)	$1,345 (267%)	17,856 (-15%)	$1,44 (170%)
Maglev Technology				
Base Air Fare	14,797	$508	26,773	$911
150% Base	14,814 (0%)	$763 (50%)	25,058 (-6%)	$1,269 (39%)
200% Base	14,960 (1%)	$1,041 (105%)	23,720 (-11%)	$1,622 (78%)
300% Base	15,404 (4%)	$1,655 (227%)	22,045 (-18%)	$2,352 (158%)

Note: Figures are for local travel only. Percent change from baseline scenario indicated in parentheses.

Source: Charles River Associates, 1996 (c).

Auto Operating Costs

The impact of increased automobile operating costs was tested by applying additional tolls of $0.05 and $0.10 per vehicle mile. This resulted in ridership gains of 5 to 6 percent with the $0.05 per mile toll and 10 to 13 percent for the $0.10 per mile toll (see Table 4.10. The ridership impact would be slightly greater for a VHS system than for a Maglev system. The revenue impacts of increased auto operating costs would be somewhat less than proportional to the ridership impacts, as the increased ridership would be drawn from trips previously made by auto, which tend to be shorter distance trips with lower high-speed rail fares per passenger.

Business Airfare Surcharges

The impact of business airfare surcharges[5] of $25 or $50 was tested with two variations (see Table 4.11). Under the first variation, the surcharge did not impact the high-speed rail fare. Under the second variation, the surcharges were included in the base airfares on which high-speed rail fare are based. Leaving the original high-speed rail fares in place (the first variation) resulted in ridership gains of 7-12 percent for the $25 surcharge and 12-27 percent for the $50 surcharge. The greatest ridership gains were seen for the basic VHS system (12-27 percent). Not surprisingly, including the surcharges in the base high-speed rail fare resulted in negligible ridership increases.

The results for revenue impacts were somewhat different, however. Revenue impacts were greater under the second analysis variation (increasing the base high-speed rail fare in relation to the airfare). In this case, the largest percent increase in revenue was seen for the basic Maglev system (42-45 percent).

4.6.3 High-Speed Rail Fares

High-speed rail fares were based on 70 percent of the average Los Angeles – Bay Area airfare for the baseline forecasts, as described earlier. A number of fare structures were tested to examine the impacts of alternative fare structures on revenue and ridership.

Increased Central Valley High-Speed Rail Fares

Two alternative high-speed rail fare structures tested the impact of higher fares paid by Central Valley passengers (see Figure 4.8). Both fare structures assumed an initial boarding charge of $20 and the maximum fare would be reached at the halfway point between the Bay Area and Los Angeles. Maximum fares tested included 70 percent and 90 percent of the average 1995 airfare between the Bay Area and Los Angeles. The 70 percent fare structure resulted in ridership losses on the order of 5 percent and, with the exception of the Maglev system with extensions, very modest gains in revenue (see Table 4.12). The 90 percent fare resulted in significant ridership losses (19 to 25 percent) and modest revenue gains. On the whole, increased fares for the shorter Central Valley trips do not appear to be justified in light of the ridership price paid for very minor revenue gains.

[5]In practice, such surcharges would likely be applied to peak period travel.

Table 4.10 Sensitivity Analysis – Auto Operating Costs

	Basic System (without extensions)		With Extensions	
Auto Cost Scenario (SR-99 Base Alignment)	**Ridership (000s)**	**Revenue ($ million)**	**Ridership (000s)**	**Revenue ($ million)**
VHS Technology				
Base Auto Cost	11,102	367	20,960	684
$0.05/VMT Toll	11,738 (6%)	385 (5%)	22,222 (6%)	720 (5%)
$0.10/VMT Toll	12,476 (12%)	406 (11%)	23,644 (13%)	762 (11%)
Maglev Technology				
Base Auto Cost	14,797	508	23,773	911
$0.05/VMT Toll	15,510 (5%)	529 (4%)	28,144 (5%)	951 (4%)
$0.10/VMT Toll	16,329 (10%)	552 (9%)	26,669 (11%)	995 (9%)

Note: Figures are for local travel only. Percent change from baseline scenario indicated in parentheses.

Source: Charles River Associates, 1996 (c).

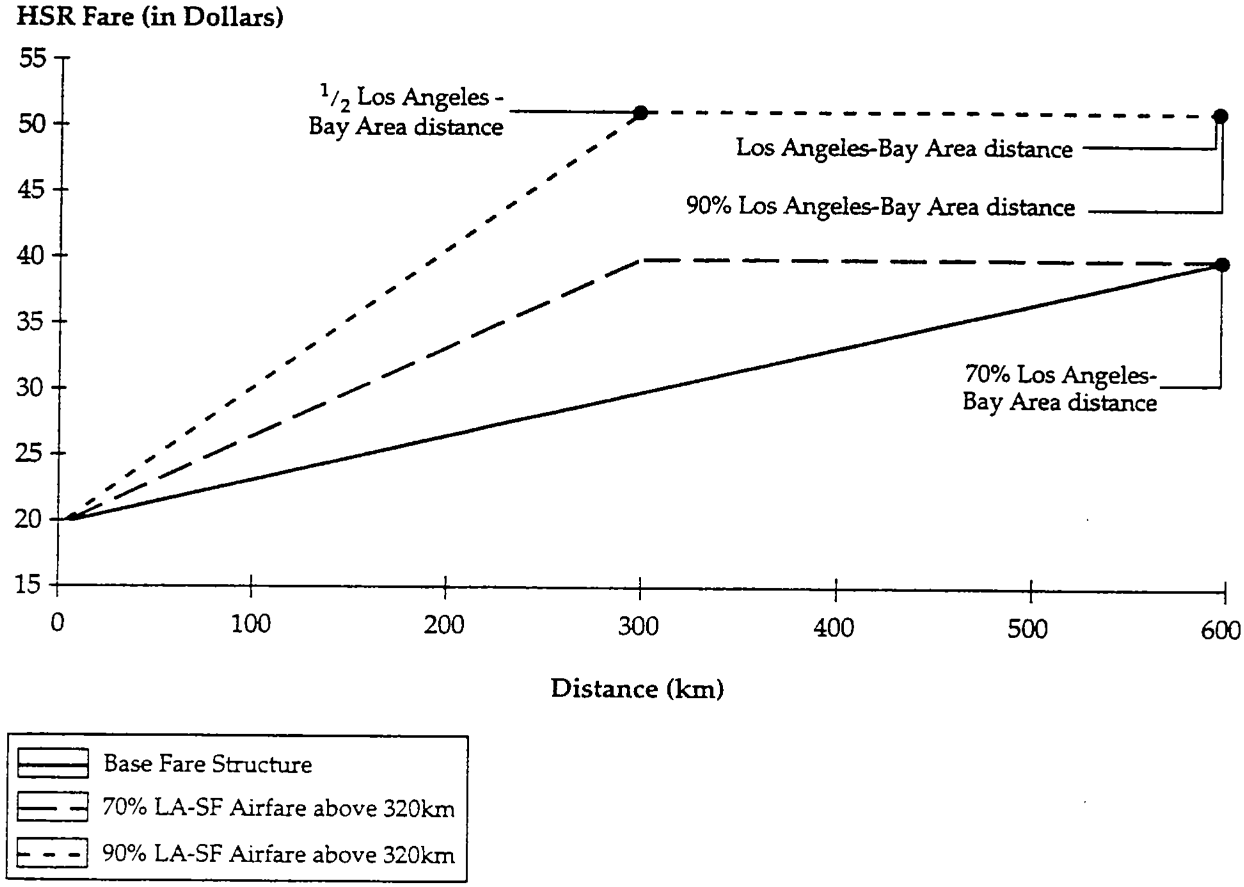
Table 4.11 Sensitivity Analysis – Business Air Fare Surcharges

High-Speed Rail Fare Scenario (SR-99 Base Alignment)	Basic System (without extensions) Ridership (000s)	Basic System (without extensions) Revenue ($ million)	With Extensions Ridership (000s)	With Extensions Revenue ($ million)
VHS Technology				
Base Fare	11,102	367	20,960	684
$25 air surcharge	12,599 (12%)	442 (20%)	22,861 (9%)	784 (15%)
$50 air surcharge	14,121 (27%)	519 (41%)	24,710 (18%)	881 (29%)
$25 air surcharge (w/HSR increase)	11,053 (0.4%)	441 (20%)	20,442 (2%)	792 (16%)
$50 air surcharge (w/HSR increase)	11,067 (0.3%)	522 (42%)	20,055 (4%)	897 (31%)
Maglev Technology				
Base Fare	14,979	508	26,773	911 (%)
$25 air surcharge	16,276 (10%)	583 (15%)	28,588 (7%)	1007 (11%)
$50 air surcharge	17,577 (19%)	647 (27%)	29,979 (12%)	1,081 (19%)
$25 air surcharge (w/HSR increase)	14,732 (0.4%)	618 (22%)	26,154 (2%)	1,072 (18%)
$50 air surcharge (w/HSR increase)	14,731 (0.4%)	735 (45%)	26,665 (4%)	1,227 (35%)

Note: Figures are for local travel only. Percent change from baseline scenario indicated in parentheses.

Source: Charles River Associates, 1996 (d).

Figure 4.8 Alternative High-Speed Rail Fare Structures



Source: Charles River Associates, 1996.

Table 4.12 Sensitivity Analysis – High-Speed Rail Fares

Auto Cost Scenario (SR-99 Base Alignment)	Basic System (without extensions) Ridership (000s)	Basic System (without extensions) Revenue ($ million)	With Extensions Ridership (000s)	With Extensions Revenue ($ million)
VHS Technology				
Base Fare (70% of airfare)	11,102	367	20,960	684
70 % of airfare above 320 km	10,503 (-5%)	373 (2%)	19,908 (-5%)	687 (2%)
90 % of airfare above 320 km	8,340 (-25%)	371 (1%)	16,198 (-23%)	699 (1%)
Maglev Technology				
Base Fare (70% of airfare)	14,797	508	26,773	911
70 % of airfare above 320 km	14,119 (-5%)	515 (1%)	25,653 (-4%)	909 (-0.2%)
90 % of airfare above 320 km	11,677 (-21%)	538 (6%)	21,604 (-19%)	966 (6%)

Note: Figures are for local travel only. Percent change from baseline scenario indicated in parentheses.

Source: Charles River Associates, 1996 (c).

Revenue Maximizing High-Speed Rail Fares

A series of forecasts varying the high-speed rail fare base from 60 percent to 110 percent of the average airfare illustrates the relationship between ridership and revenue maximization. As shown in Figure 4.9, ridership steadily decreases when high-speed rail fare is between 60 percent and 110 percent of airfare but the farebox revenue is maximized at about 80 percent of airfare for a VHS system and 100 percent of airfare for a Maglev system. This tradeoff between ridership and revenue is an important policy issue that must be addressed in implementing the system.

4.7 Commuter Patronage Potential

As mentioned earlier in this chapter, the focus of the study is on intercity travel. The forecasts presented earlier do not include "commute" trips. While the main purpose of the high-speed rail system is to serve intercity travel, the Commission recognized that the high-speed rail infrastructure might serve certain long distance commute trips as well. Excess capacity can be used by a separate service aimed at diverting long-distance automobile commuters to rail, thus increasing the overall benefits of the system (commute trips are defined as those made regularly three or more times per week). A separate but complementary analysis of commuter patronage potential was developed. This analysis is much less detailed than the analysis for intercity travel and is intended only to suggest market potential and to differentiate among corridor options.

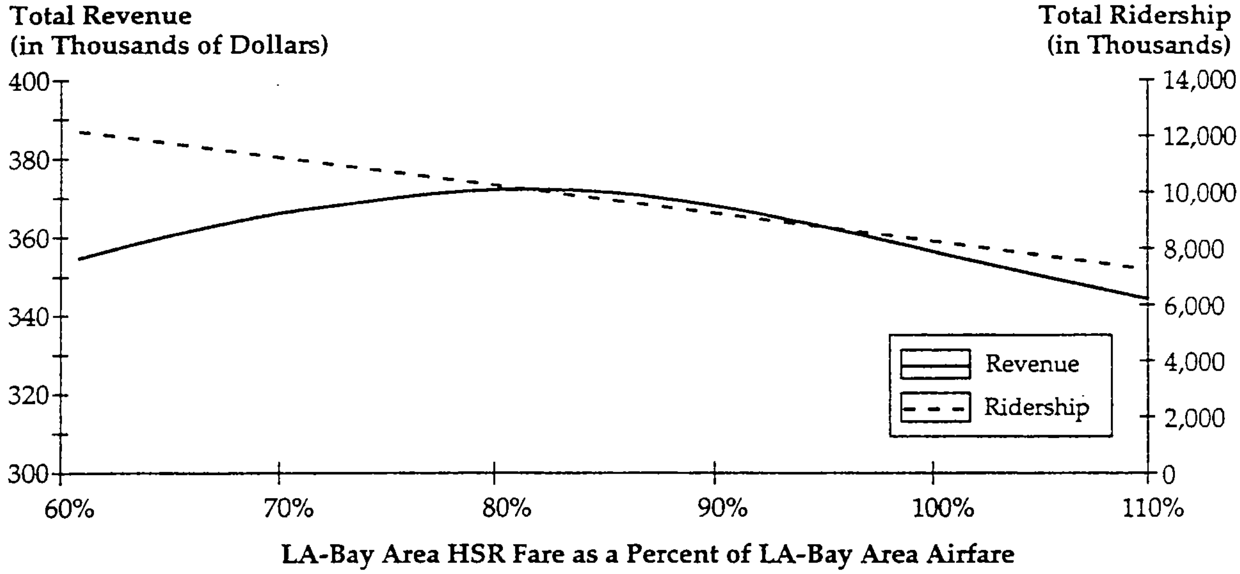
The analysis assumed that commute trips are served by weekday service only. Trains would arrive every 20 minutes during peak periods and every 1-2 hours during off-peak periods. The analysis was not capacity constrained. The assumed fare structure was based on a $6 total fare between Palmdale Los Angeles and Union Station. Assuming a boarding charge of $2, this results in a mileage charge of 6.4 cents per mile. Because of the low fares needed to attract large volumes of commuter traffic, revenue from these services would probably not cover operational costs. The commuter services would need to be publicly subsidized and operated by public operators such as Metrolink, SamTrams, or BART.

The analysis concluded that high-speed rail commute service could attract between 2.7 and 3.7 million annual riders on each corridor in the year 2015 (see Table 4.13). The commute corridor with the highest ridership and revenue potential is Bakersfield to Los Angeles via the Antelope Valley. This is the longest commute corridor with the highest average travel speeds. The high-speed rail commute service in this corridor would capture over 60 percent of the inbound commute market. The commute corridor between Bakersfield and Los Angeles via I-5, without a station in the Palmdale/Lancaster areas, would have the lowest annual ridership.

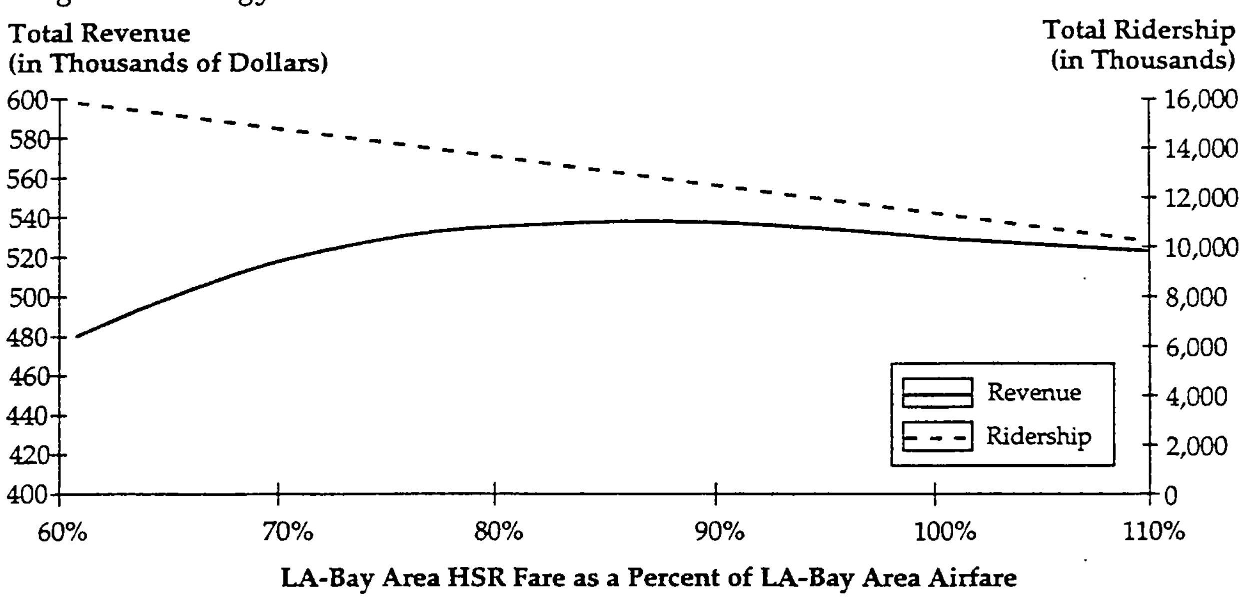
In Northern California, the high-speed commute service would serve a smaller share of the inbound commute market, largely because of the shorter distances involved. The commute corridor from Gilroy to San Francisco has the lowest annual revenue potential of the corridors, mainly due to its shorter end-to-end distance and the presence of more stations closer to the endpoints.

Figure 4.9 High-Speed Rail Ridership and Revenue at Varying Percentages of Airfare (SR-99 Base Alignment with Extensions, 2015)

VHS Technology



Maglev Technology



Note: Figures are for local travel only.

Source: Charles River Associates, 1996.

Table 4.13 Commute Patronage Potential, Year 2015

	Annual Ridership (millions)	Annual Revenue ($millions)	Revenue Per Rider	Inbound End-to-End Market Share
1. Bakersfiled to Los Angeles via I-5	2.7	$15	$5.56	69%
2. Bakersfield to Los Angeles via SR 14	3.7	$23	$6.13	61%
3. Gilroy to San Francisco	2.8	$11	$3.74	24%
4. Stockton to San Francisco CBD	3.0	$13	$4.20	33%

Source: Dowling Associates

The forecasted high-speed commute ridership is considerably higher than existing commuter rail ridership in Southern California (Metrolink's Santa Clarita line had 800,000 revenue passengers in 1995) but lower than the existing ridership in Northern California (CalTrain had about 7 million revenue passengers in FY 1990/91). This is because in Southern California, introduction of high-speed commute service would significantly increase the extent and quality of commuter rail service. In the Bay Area, the existing CalTrain commuter trains serve 34 stations in the Gilroy-San Francisco Corridor. The proposed high-speed commute service would serve only five stations in this Corridor, effectively functioning as the CalTrain "express" rather than competing with or replacing the existing service. However, additional work will be necessary to determine how a high-speed commute service would interface with existing commuter services.

4.8 Forecasting Methodology

4.8.1 Overview

This section describes the process used to forecast intercity high-speed rail ridership and passenger revenue in California. The forecasting process involved three main steps:

1. Forecast the size of the total intercity travel market in the Corridor for the year 2015; including future air, auto, and conventional rail travel.

2. Estimate the number of passengers that would divert to high-speed rail, given the level of service characteristics of high-speed rail and the competing modes.

3. Estimate the amount of induced travel demand for high-speed rail. Induced demand consists of trips that would not otherwise have been made prior to the introduction of high-speed rail.

Extensive data collection and model estimation efforts supported the three-step forecasting process, as illustrated in Figure 4.10. These data supported the estimation of *total demand models* and *diversion or mode choice models*. The following sections describe these efforts in more detail.

4.8.2 Data Inputs

Surveys

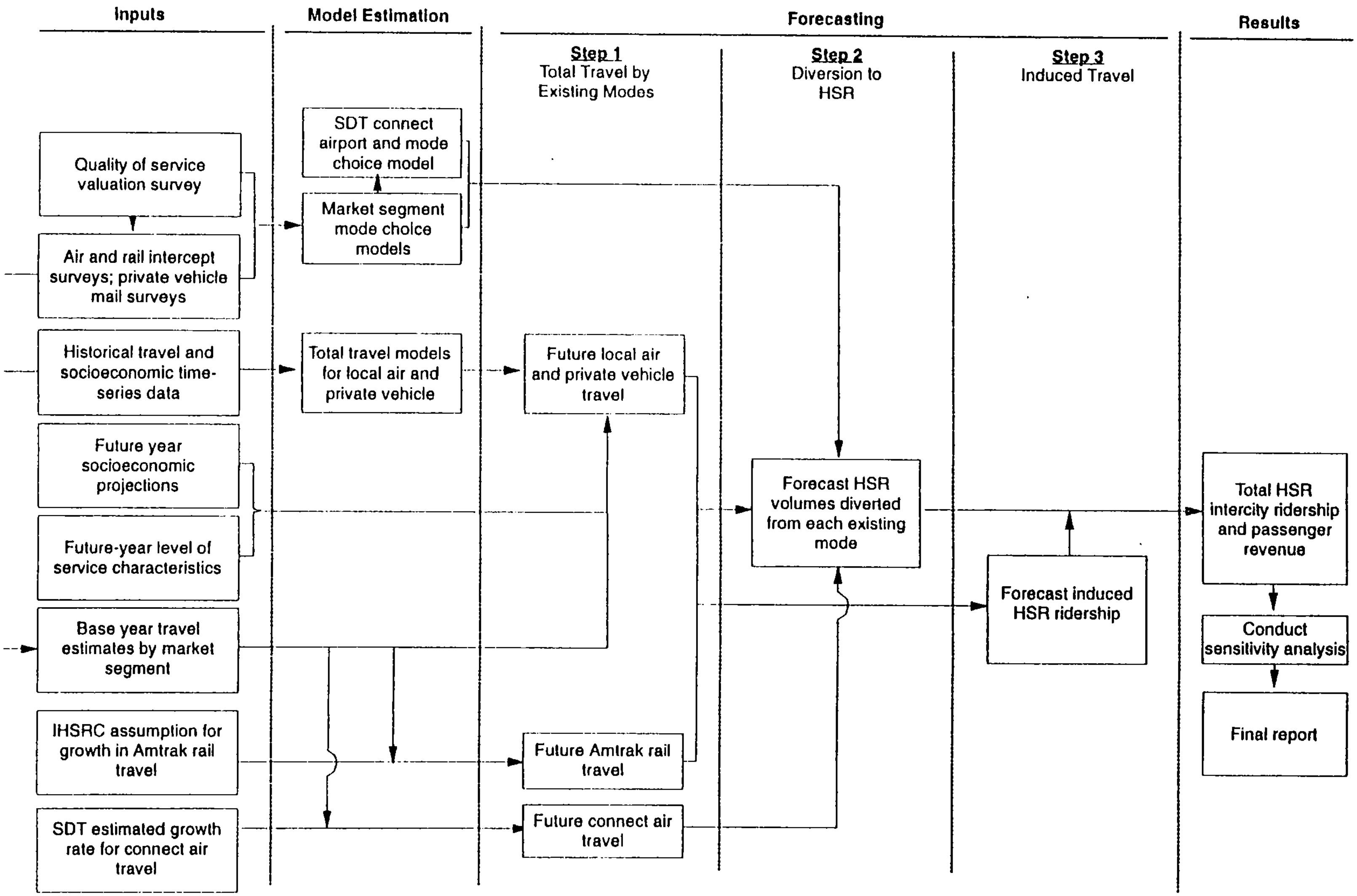
Surveys of intercity travelers were conducted in order to understand the current origin and destination patterns of private vehicle travel, determine the percentage of intercity travel undertaken for business and non-business purposes, understand how people value or weigh attributes such as travel time and out-of-pocket cost, and measure traveler preferences for special service features provided by high-speed rail. The surveys included (sample sizes are for completely usable responses):

- A mail survey of 15,713 California households detailing recent intercity travel in the Corridor;
- Surveys of 1,495 air passengers and 2,818 rail passengers, intercepted as they traveled within the Corridor;
- A survey of 1,983 recent private vehicle trip makers; and
- A computer-assisted Quality of Service survey of 957 recent travelers in the Corridor.

In addition to gathering information on actual trips, the surveys of air, rail, and private vehicle travelers used a technique known as Value Perception Analysis (VPA) to gather information on how people would respond to high-speed rail, an entirely new mode of transportation. Because no high-speed rail system currently exists in the United States, it is not possible to observe the travel time and cost tradeoffs made by travelers choosing among air, auto, and high speed rail. Therefore, survey respondents were asked to rank several hypothetical mode alternatives, including high-speed rail based on the alternatives, travel times, and costs.

The Quality of Service survey was administered at seven shopping malls located throughout the length of the Corridor. Its objective was to measure the value placed on special high-speed rail attributes such as more spacious seating, features for business travelers (work tables, computer connections, etc.), service reliability, and enhanced luggage-handling arrangements. An actual intercity trip recently made by survey respondents served as the "reference trip" to which hypothetical travel alternatives were compared.

Figure 4.10 Intercity Ridership and Revenue Forecasting Process



Source: Charles River Associates, 1996.

Other Data

An extensive database of current intercity travel characteristics, historical data, and future projections served as model inputs or model estimation data sources. Some of the data sources were developed from survey data, others from secondary sources such as the California Department of Finance, or traffic network models maintained by Metropolitan Planning Organizations in the Corridor. These data are summarized in Table 4.14.

4.8.3 Model Estimation

Total Demand Models

Separate total demand forecasting models for air and auto travel incorporate the effects of differential growth rates by mode and geographic region. Both models were estimated from historical data and applied to forecast travel between metropolitan area pairs (e.g. Sacramento – San Diego or Los Angeles-San Francisco). Variables in the air demand model included population and per capita income in the origin and destination areas, average fare, travel time, and a "dummy" variable to capture the unique characteristics of each metropolitan area. The auto travel demand model was based on total real income in the origin and destination areas (incorporating the effects of population and income) and distance. Forecasted travel volumes between metropolitan areas were distributed to smaller analysis zones within each area using relationships incorporating population, employment, and the number of motel rooms in each zone. The relationships for distributing trips were derived from the survey data.

Diversion Models

Separate diversion models were developed for each existing intercity travel mode and trip purpose to reflect the varying characteristics of local air, connecting air, auto, conventional rail, business, and non-business travelers. A business person traveling by air, for example, is likely to place more weight on travel time and less weight on fare when deciding how to travel. A family making an intercity trip by auto is relatively more sensitive to travel cost than to travel time. Developing separate diversion models (also termed binomial mode choice models) for each market segment results in more accurate forecasts of diversion to high-speed rail. In total, ten diversion models were estimated:

- Local air travel (business and non-business, separately);
- Connect air travel (business and non-business);
- Intercity private vehicle travel (business and non-business);
  - Short (up to 150 miles);
  - Long (greater than 150 miles); and
- Conventional rail travel (business and non-business).

Table 4.14 Major Database Items and Sources of Data

Database Items	Sources of Data
Intercity travel volumes:	
– local air	USDOT OD1A and 298C T-1 databases
– connect air	USDOT OD1A and 298C T-1 databases
– rail	Amtrak/Caltrans
– private vehicle	Household mail survey
Intercity line-haul travel times & service frequencies:	
– local air	Official Airline Guide
– connect air	Sabre Decision Technologies
– rail	Amtrak timetables
– private vehicle	Caltrans network; MPO networks
Intercity out-of-pocket costs:	
– air	USDOT OD1A database
– rail	Amtrak, Air and rail intercept surveys
– private vehicle	Route & mileage-based estimates, Survey C
Access/egress times & costs:	
– all modes	State/local/MPO networks
Terminal processing times:	
– all common carrier modes	Estimates, reflecting terminal designs
Demographic/socioeconomic characteristics of the region:	
– population, per capita income, hotel rooms	Division of Finance, CCSCE, MPOs, AAA
Stratification of trips by purpose and captivity:	
– purpose: all existing modes	Air and rail intercept surveys, private vehicle tripmaker survey
– captivity: private vehicle	Private vehicle tripmaker survey

Source: Charles River Associates, 1996.

The general form of the diversion models is given by:

$$S_{OD}^{m,HSR} = f(time_{OD}^{m,HSR}, cost_{OD}^{m,HSR}, frequency_{OD}^{m,HSR}, constant^{m,HSR})$$

where

$S_{OD}^{m,HSR}$	=	share of existing mode m trips between areas O and D that will divert to high-speed rail;
$time_{OD}^{m,HSR}$	=	access, egress, line-haul travel and terminal processing time components for mode m and for high-speed rail;
$cost_{OD}^{m,HSR}$	=	access, egress, and line-haul travel cost components for mode m and for high-speed rail;
$frequency_{OD}^{m,HSR}$	=	measures of the frequency for mode m and for high-speed rail; and
$constant^{m,HSR}$	=	effect of other characteristics of high-speed rail relative to mode m.

Using a binomial logit formulation, the probability of a traveler choosing high-speed rail over another mode may therefore be expressed as follows:

$$Share_{HSR_{mkt.\ seg.}} = \frac{e^{\mu_{HSR_{mkt.\ seg.}}}}{e^{\mu_{HSR_{mkt.\ seg.}}} + e^{\mu_{existing\ mode_{mkt.\ seg.}}}}.$$

The utility or attractiveness of each mode, represented in the above equation by μ is given by:

$$\mu = \alpha + \sum_{n=1}^{N} \beta_n \chi_n + \varepsilon$$

where

μ = utility,

α = modal constant,

$\beta_1 - \beta_N$ = coefficients for N level of service variables,

$\chi_1 - \chi_N$ = values for the N level of service variables, and

ε = disturbance or error term.

While the variables that make up the different diversion models are similar, the weights or coefficients placed on the variables vary according to the market segment. The final mode choice model coefficients are presented in Table 4.15.

4.8.4 Forecasting

The three-step intercity ridership forecasting process applied the total air and private vehicle demand models, with the appropriate future-year input data, to forecast total local and connect air and private vehicle travel. Future year intercity travel by conventional rail was kept constant at current levels. Next, the separate diversion models were applied to the future local air, rail, and private vehicle volumes to forecast high-speed rail travel diverted from each mode. An airline connecting traffic model (see below) was applied to forecast high-speed rail travel diverted from this market segment. Finally, estimates were made of the travel that would be induced on high-speed rail (see below). Diverted and induced travel were then combined to produce the total high-speed rail intercity ridership and passenger revenue projections presented in this report.

Diversion of Connecting Air Passengers

A specialized model used by the airline industry generated estimates of connecting air travel that could be diverted to high-speed rail. Thus, for example, passengers might board a train in Fresno and transfer at San Francisco International Airport (SFO) for a flight to New York. The model accounted for airline schedules, the effect of computerized reservation systems which generate itineraries and connections, and the potential for code-sharing with airlines. In the final forecasts, diverted connecting air traffic was included only in those scenarios incorporating a direct connection to SFO (A station at LAX was not included in the final baseline alternatives.) Code sharing with one major U.S. airline was assumed.

Table 4.15 Mode Choice Model Coefficients

Local Air Models

Variable	Business	Nonbusiness
Modal constant	0.0993	0.1174
	(1.17)	(1.48)
Line-haul time	-0.0357	-0.0373
	(-14.24)	(-13.94)
Access/egress time	-0.0382	-0.0410
	(-8.29)	(-13.94)
Wait time	-0.0207	-0.0321
	(-4.17)	(-6.33)
Cost	-0.0505	-0.0744
	(-9.65)	(-12.44)

Connect Air Models

Variable	Business	Nonbusiness
Modal constant	0.3165	0.1873
	(3.56)	(2.01)
Line-haul time	-0.0387	-0.0255
	(-5.87)	(-4.75)
Cost	-0.0383	-0.0496
	(-3.54)	(-5.02)
Terminal Transfer[1]	-0.3791	-0.2299
	(-2.01)	(-4.75)

Private Vehicle (Short Distance) Models

Variable	Business	Nonbusiness
Modal constant	-0.6600	-1.0369
	(-4.40)	(-9.10)
Line-haul time	-0.0142	-0.0057
	(-4.86)	(-3.07)
WALH (see below)	-0.0175	-0.0350
	(-5.09)	(-7.64)
Cost	-0.0450	-0.0553
	(-6.34)	(-9.34)

Table 4.15 Mode Choice Model Coefficients (continued)

Private Vehicle (Long Distance) Models

Variable	Business	Nonbusiness
Modal constant	-0.7995	-0.8768
	(-1.43)	(-3.33)
Line-haul time	-0.0110	-0.0066
	(-3.33)	(-4.54)
Access/egress time	-0.0184	-0.0093
	(-1.70)	(-1.98)
Wait time	-0.0060	-0.0031
	(-2.65)	(-1.98)
Cost	-0.0260	-0.0293
	(-2.69)	(-5.13)

Conventional Rail Models

Variable	Business	Nonbusiness
Modal constant	0.7848	0.5226
	(10.80)	(11.45)
Line-haul time	-0.0254	-0.0197
	(-8.95)	(-11.41)
Access/Egress time	-0.0325	-0.0212
	(-8.24)	(-8.81)
Wait time	-0.0225	-0.0144
	(-11.42)	(-12.16)
Cost	-0.1046	-0.0860
	(-11.70)	(-16.03)

Definition of WALH Term in Private Vehicle (Short Distance) Model

Business	Nonbusiness
((1 * Wait Time) * (1.5 * Acc/Egr Time))/Line-haul Time	((0.5 * Wait Time) * (1.5 * Acc/Egr Time))/Line-haul Time

Notes: t-statistics are in parentheses.
(1) Terminal Transfer is defined as transfer in same terminal (=0), or transfer in different terminal (=1).

Source: Charles River Associates, 1996.

Approach to Estimating Induced Demand

Induced travel was estimated as the third step in the three step ridership forecasting process. The introduction of high-speed rail service will improve the overall level of service for intercity travel within the Corridor. For example, the addition of high-speed rail will increase the frequency of high speed common carrier service, the centralized location of stations will reduce the average time and cost required for traveling to and from terminals. The new mode will provide comfort and other quality of service improvements for many travelers. These improvements will make conditions more favorable for travel, and will decrease the disutility of travel. Trips will be taken on high-speed rail that would not otherwise have been made using any of the current modes (air, rail and private vehicle). These new trips made on the new or improved mode, in addition to those diverted from the existing modes, are commonly referred to as induced trips. Induced demand can be defined as:

$$\textit{Induce Travel} = \textit{Total Travel}_{\textit{with HSR}} - \textit{Total Travel}_{\textit{before HSR}}$$

Induced travel for a new mode like high-speed rail should be closely tied to the user benefits that make it attractive to users of existing modes. A new mode that is able to capture 30 to 40 percent of an existing market is very likely to induce additional trips not currently being made. Alternatively, if the mode attracts only 1 percent of existing trips, it is unlikely that much induced demand can be expected. Because of this relationship between induced travel and diverted travel, the model used to calculate induced demand incorporates a measure of travel utility which is consistent with that used in the diversion models. For additional discussion of induced demand, please see Chapter 5.0, *Forecasting Models,* of the ridership study's final report.